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TECHNOLOGY IN BROILER PRODUCTION

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IMPACT ON FEED CONVERSION AND MARKETING WEIGHT

U. S. DEPARTMENT OF AGRICULTURE/ECONOMIC RESEARCH SERVICE/ERS-246

CONTENTS

	Page
Summary	iv
Introduction	1
Improvement in Broiler Production Efficiency	1
Maximizing Net Returns Per Broiler	3
Maximizing Annual Net Income	4
The Price-Mapping Method	6
Technology and Commercial Broiler Production	11
Literature Cited	15

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SUMMARY

In the production of meat animals and poultry, successive inputs of feed yield diminishing gains in weight as the animal or bird matures. Therefore, high product-feed price ratios increase the most profitable marketing weight. Conversely, low price ratios decrease the most profitable weight. Insofar as the net return per individual animal or bird is concerned, this marginal principle is as applicable to broiler production as it is to beef cattle or hogs.

However, maximizing net returns per meat animal also maximizes the annual net returns of the entire enterprise as well, since the number of animals fed is seldom affected by the weight at which they are marketed. In commercial broiler production, on the other hand, the marketing weight which maximizes net returns per bird does not necessarily maximize the grower's annual net returns, because the weight at which he markets his broilers does affect the number he can market in a year. For this reason, the usual type of marginal analysis is not very helpful in determining the marketing weight of broilers that will maximize the broilerman's annual net returns.

A price-mapping method has been developed by which optimum marketing weights can be readily determined for a wide range of broiler and feed prices. When used to compare an earlier with a more recent production function, this analytical method indicates that technological change has materially lessened the relative cost disadvantage of heavier broilers. This cost factor, together with pressure to reduce processing costs and perhaps some shift in market preferences, appears to have been primarily responsible for the gradual rise in broiler marketing weights in recent years. The relationships between prices, output, and average live weights are further illustrated with seasonal data.

TECHNOLOGY IN BROILER PRODUCTION
Impact on Feed Conversion and Marketing Weight

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INTRODUCTION

The pace and the nature of technological change in the broiler industry have no parallel in the record of animal agriculture. Because of improvements in breeding, feeding, disease control, housing, and equipment, broiler growers now get considerably faster and cheaper gains than even 10 years ago. Industry-grower coordination has speeded the adoption of more efficient production methods and has upgraded the average level of management skill used in production. Cost reductions have combined with the ready supply response (2, 6, 20) 1/ of the industry to produce a sevenfold expansion in output since World War II. This expansion has occurred in spite of a strongly downward price trend; prices in 1961-64 averaged less than half the levels of the late 1940's. Clearly, technology has drastically shifted the broiler supply curve (fig. 1).

This report has four purposes: (1) It presents some indications of the extent of improvement in broiler production efficiency. (2) It shows the striking increase that this gain in efficiency has brought about in the live weight at which net returns per broiler are maximized. (3) It develops a price-mapping procedure to determine optimum marketing weights where producers must consider not only net returns per broiler, but the effect of production-time and floor-space limitations on the number of broilers that can be produced annually. (4) It uses this price-mapping method to show how technological change and lower broiler-feed price ratios have jointly reduced the competitive disadvantage of heavier broilers.

IMPROVEMENT IN BROILER PRODUCTION EFFICIENCY

Experimental work over the last 40 years shows marked improvements in the speed and economy of broiler gains. In a 1925 experiment by Jull and Titus (13), it took 16 weeks and 12 pounds of feed to produce a 3.5-pound chicken (fig. 2). In the early 1950's, Judge and Fellows (11), Card and Scott (4), and Wabeck and Skoglund (21) reported feed consumption of approximately 10 pounds for a 3.5-pound broiler in 12 weeks. More recently, Wabeck and Skoglund (21) and the SPICE Subcommittee (17) reported trials in which broilers attained a weight of 3.5 pounds in 8 weeks with 7.5 to 8 pounds of feed.

1/ Underscored numbers in parentheses refer to Literature Cited, p. 15.

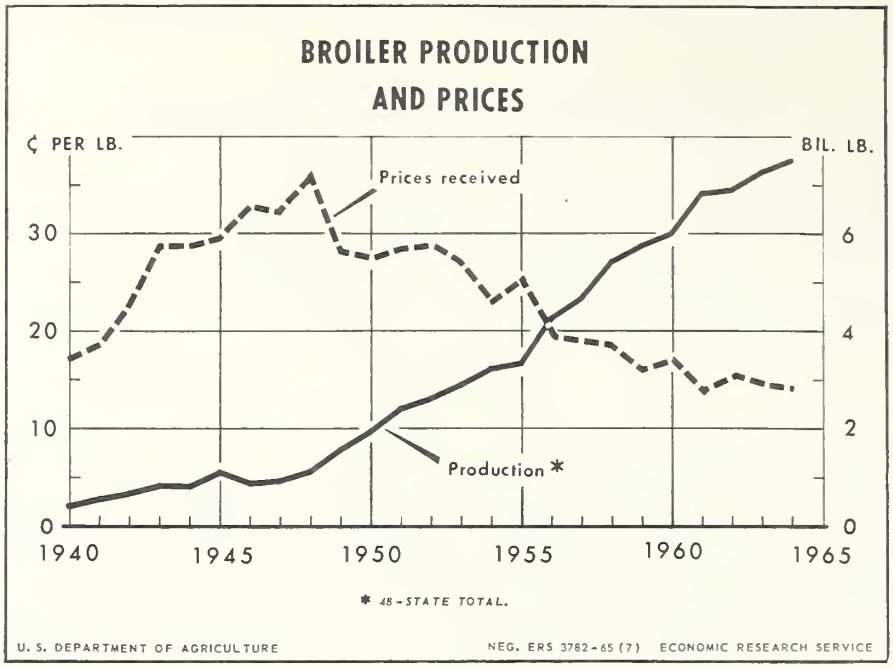

Figure 1

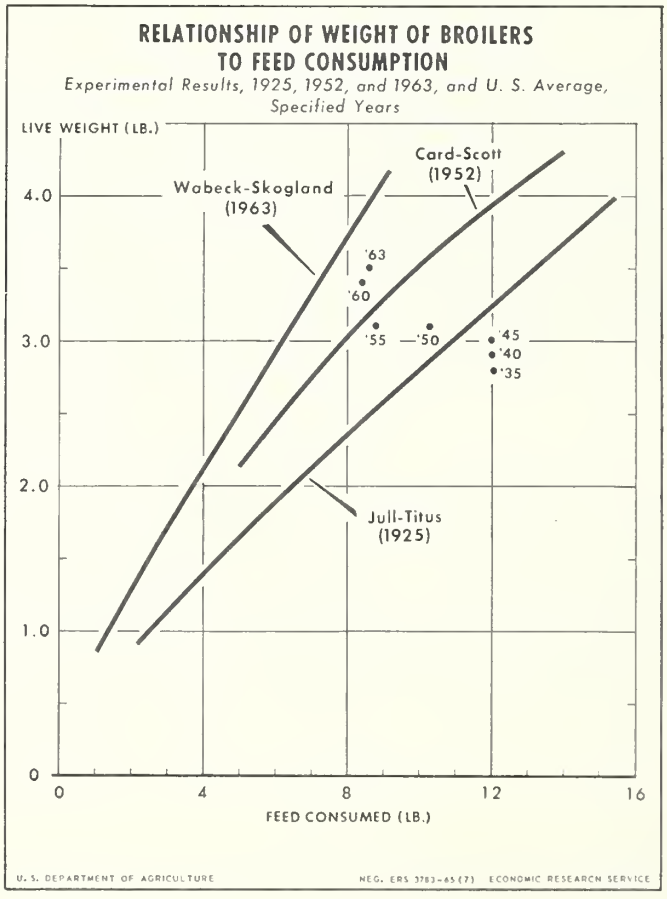

Figure 2

The gap between the "technological potential," as represented by experimental results, and rates of performance actually achieved by commercial producers appears to have greatly narrowed. Before World War II, when most broilers were produced by small, independent growers, there was a substantial lag between the best production efficiency known at the time and that which prevailed in the industry itself. But today, many commercial producers equal or exceed experimental results. Thus, a comparison over time of experimental results probably understates the degree of improvement in the production efficiency of the commercial broiler industry. Hodges estimates that the average rate of feed conversion in commercial broiler production was 4.2 pounds per pound of live weight in 1940, 3.3 pounds in 1950, and 2.5 pounds in 1963 (10). Since feed makes up a high proportion of total costs, these reductions account for a major portion of the improvement in broiler production efficiency.

Drastic reductions in the amount of labor needed in broiler production are a second important source of improved efficiency. Faster gains, better designed buildings, and increased mechanization are mainly responsible. It is estimated that the average amount of labor used per 100 pounds of broilers marketed dropped from 3.1 man-hours in 1950-51 to about 1 man-hour in 1960-61 (18).

MAXIMIZING NET RETURNS PER BROILER

Before World War II, the major part of our chicken meat supply was a byproduct of egg production, and thus was highly seasonal. As a result, many growers found it to their advantage to market broilers only during those months when the most favorable prices could be expected. Most broilermen were small, independent farm operators during that period, and the production of broilers was a spare-time, off-season activity for them. Little was known of the effect of floor space per bird on mortality or on feed conversion. The number of birds marketed annually was "fixed," that is, independent of the weight at which the grower expected to market them. In this situation, the weight decision affected neither the number of lots to be started nor the number of chicks started per lot. Thus, where intermittent single lots were started and neither labor nor floor space was a limiting factor, the central economic question was the marketing weight at which net returns per broiler were greatest. With a given number of broilers marketed per year, this automatically maximized the grower's annual net returns from broiler production.

Net returns per broiler are highest when the value of the additional gain just equals the cost of the feed used to produce it. Therefore, it pays to continue feeding to the point where the marginal feed input (the quantity of feed it takes to produce an additional pound of gain) rises to equal the broiler-feed price ratio. 2/ With any given production function (in this instance the relationship between feed and weight), a higher broiler price in relation to the price of feed raises the most profitable weight at which broilers are marketed. Studies by Smith (15), Baum and Fletcher (1), and Heady, Balloun, and McAlexander (9) illustrate this type of analysis.

2/ This may be expressed as $\Delta Q_B P_B = \Delta Q_F P_F$ or $\Delta Q_F / \Delta Q_B = P_B / P_F$ where ΔQ_B represents the weight gain, ΔQ_F the accompanying increase in feed consumed, P_B the price of broilers, and P_F the price of feed. This assumes that the market does not discriminate between one size of broiler and another.

No one has yet developed a composite production function for the commercial broiler industry which shows the relationship between feed inputs and weight gains. However, a comparison of past experimental results can indicate the direction of change in the commercial industry and something of its rate. The 1952 Card-Scott results probably are somewhat better than the rates of performance by commercial growers at that time (table 1). The Wabeck-Skoglund work, however, appears to give a good approximation of the production function facing commercial producers in 1963, or at least the more efficient growers who produced the bulk of the output.

If a comparison of the 1952 Card-Scott and 1963 Wabeck-Skoglund data gives any indication, technological change has produced a striking increase in the weight at which net returns per broiler are maximized. With the Card-Scott function, net returns per broiler are highest at about 3.75 pounds with a broiler-feed price ratio of 5 to 1, and at 4.25 pounds with a ratio of 6 to 1 (table 1, column 6). The much more economical gains in the Wabeck-Skoglund tests are reflected in the more steeply rising curve in figure 2 and in the substantially lower feed consumption in table 1 (column 4 vs. column 9). Moreover, the rate of feed conversion in the Wabeck-Skoglund function is better maintained into the heavier weights than in the Card-Scott one; this is reflected in the lesser curvature of the top line in figure 2, and in the much more gradual increase of the marginal feed inputs shown in table 1 (column 11 vs. column 6). The fact that the rate of feed conversion does not fall off as rapidly at the heavier weights means that the relative cost disadvantage of heavier broilers has been sharply reduced. The marginal feed input of the Wabeck-Skoglund function rises so gradually that the net returns per broiler, even with current price ratios of around 3 to 1, are not maximized within the range of the data, but somewhere above it. A price ratio of less than 2.7 to 1 would be required to bring the most profitable marketing weight down to 4.5 pounds (table 1, column 11).

MAXIMIZING ANNUAL NET INCOME

As pointed out above, when broilers are produced intermittently and neither labor nor floor space is a limiting factor, the number of birds started annually is not affected by the weight at which they are marketed. With a given number of birds, maximizing the net returns per bird maximizes annual net returns as well. But today, most commercial growers produce broilers continuously, with only a week or two between lots to clean out and disinfect the houses. Lighter broilers take less time per lot to produce, and less floor space per bird. More and bigger lots mean many more broilers produced annually with a given amount of floor space. 3/ Since their larger numbers more than offset their lighter weight, marketing lighter broilers enables the broilerman to expand his annual output from a given floor space.

3/ This statement assumes, as have several previous studies, that floor-space requirements increase proportionately with live weight. See studies by Hansen and Mighell (7), Judge and Fellows (11), Nurse, Trant, and Walker (14), Judge and others (12), Boone (3), Clark (5), Hartung (8), Smith and McDaniel (16), and Thayer and others (19).

Table 1.--Production time and feed consumption in broiler production, 1952 and 1963 experiments

Live weight (in pounds)	Card-Scott, 1952 1/					Wabeck-Skoglund, 1963 2/				
	Age	Lots per year	Feed consumption			Age	Lots per year	Feed consumption		
			Per broiler	Average per pound of gain	Marginal			Per broiler	Average per pound of gain	Marginal
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Days	Number	Pounds	Pounds	Pounds	Days	Number	Pounds	Pounds	Pounds
2.25	58	5.1	5.51	2.45	2.91	41	6.6	4.28	1.90	2.44
2.50	62	4.8	6.33	2.53	3.21	44	6.3	4.90	1.96	2.48
2.75	66	4.6	7.25	2.64	3.54	47	6.0	5.52	2.01	2.52
3.00	70	4.3	8.18	2.73	3.87	50	5.7	6.15	2.05	2.55
3.25	75	4.1	9.11	2.80	4.20	53	5.5	6.79	2.09	2.58
3.50	80	3.9	10.15	2.90	4.57	56	5.2	7.44	2.13	2.60
3.75	85	3.7	11.29	3.01	4.98	59	5.0	8.09	2.16	2.62
4.00	90	3.5	12.63	3.16	5.47	61	4.8	8.75	2.19	2.64
4.25	96	3.3	14.09	3.32	6.01	64	4.7	9.42	2.22	2.66
4.50	101	3.2	15.84	3.52	6.69	67	4.5	10.08	2.24	2.68

1/ These Card-Scott results were adjusted for an estimated 0.5 percent mortality per week. A quadratic-square-root function was fitted to these observations, giving the equation $Y = -2.2637 - 0.1296X + 2.2211\sqrt{X}$, with Y representing the live weight of the bird, and X the pounds of feed consumed. The marginal feed input figures in the last column were obtained by taking the first derivative of the above function, i.e., $dY/dX = -0.1296 + 1.1106/\sqrt{X}$.

2/ These Wabeck-Skoglund results were adjusted for an estimated 0.4 percent mortality per week. A quadratic-square-root function fitted to the adjusted Wabeck-Skoglund results gave the equation $Y = 0.0332 + 0.3030X + 0.4445\sqrt{X}$, and a marginal feed input of $dY/dX = 0.3030 + 0.2222/\sqrt{X}$.

Source: Hansen and Mighell (7, tables 2 and 3); Wabeck and Skoglund (21).

Because the costs of chicks, fuel, medicines, and certain other incidental items are more or less constant per chick started, these costs are higher per pound with lighter broilers. On the other hand, feed consumption per pound is lower with lighter broilers. Where average feed costs decline and average nonfeed variable costs rise as output increases, the most profitable output for a commercial broiler firm, under given price conditions, is not immediately apparent. Hence, the price-mapping method was developed.

THE PRICE-MAPPING METHOD

Hansen and Mighell published a study in 1956 which showed why optimum marketing weight is well below that for maximum returns per bird when broilers are produced in continuous lots with floor space limiting (7). They also demonstrated that, with feed at $5 per 100 pounds and nonfeed variable costs at 20 cents per chick started, the optimum marketing weight is lower with broilers at 30 cents a pound than at 25 cents because the higher price makes it profitable to expand output by marketing lighter broilers. They used the Card-Scott data, adjusted for an estimated mortality of 0.5 percent per week, for their production function. J. Nurse and others reached similar conclusions in a study published in 1960, in which they showed optimum weights for many different price-cost combinations (14).

The present study shows optimum marketing weights with a given production function for a wide range of broiler and feed prices (fig. 3). To do this graphically in two dimensions, the nonfeed variable costs are held at a fixed rate per chick started. 4/ For comparative purposes, we show one price map based on the 1952 Card-Scott data (table 2), and one based on the 1963 Wabeck-Skoglund results (table 3). These price maps are made up of a set of "zones," or combinations of broiler and feed prices, within which the designated weight of broiler is the most profitable one to produce. Locating the boundaries of the price maps does not require an iterative solution; it can be done directly by algebraic means, a method which might be described as a kind of "poor man's linear programming." This procedure is illustrated with examples drawn from the Wabeck-Skoglund results (table 3).

Zero-profit Lines

The zero-profit line for each process (weight of broiler) is determined by expressing, on a per-pound-of-output basis, the dollar value of nonfeed variable costs, and the quantity of feed. For example, in producing 3.50-pound broilers, 21,536 pounds of live broilers are produced with $762.72 worth of chicks, fuel, and medicines (63.56 x $12), and 457.84 hundredweight of feed (table 3). The net returns are:

$$N = 215.36\ P_B - 63.56\ P_C - 457.84\ P_F$$

with P_B representing the price of broilers, P_C the price of nonfeed variable items, and P_F the price of feed. Since N=O here, the zero-profit line can be expressed as any combination of broiler and feed prices that satisfies the equation:

$$215.36\ P_B = 762.72 + 457.84\ P_F$$

4/ Cost of chicks, fuel, medicines, and other nonfeed variable costs were set at $16 per 100 chicks started for the earlier Card-Scott function, and $12 for the later Wabeck-Skoglund one.

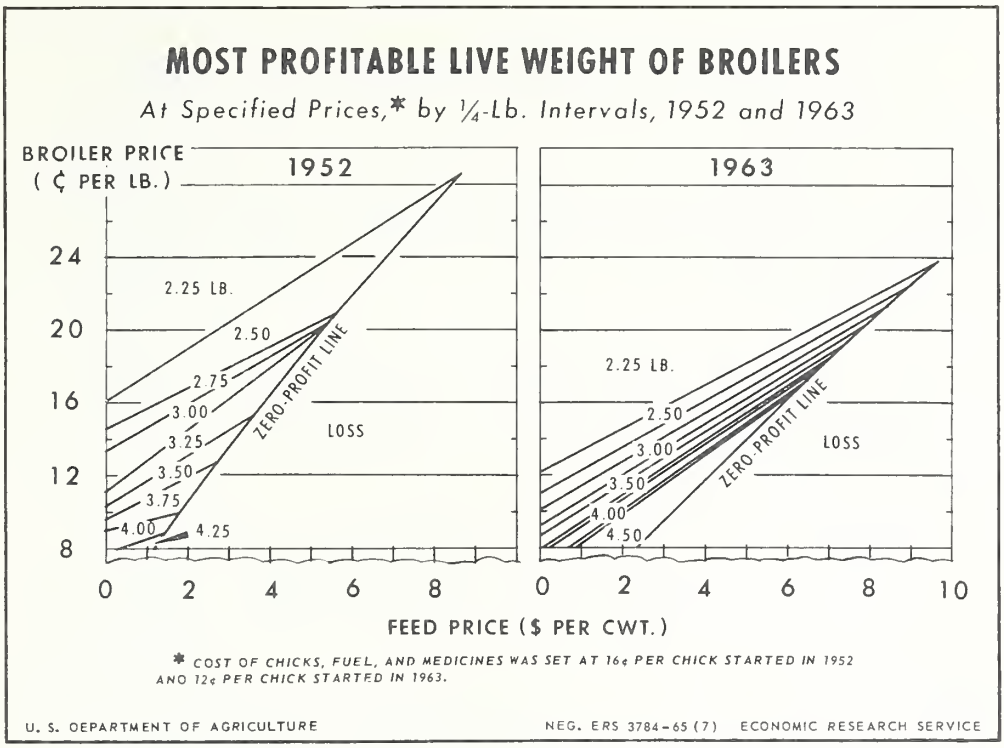

Figure 3

Dividing through by output, we get:

$$P_B = 3.5416 + 2.1259\ P_F$$

Similarly, the zero-profit line for the adjacent 3.25-pound process may be calculated as follows:

$$227.08\ P_B = (72.05)\ (\$12) + 474.63\ P_F$$
$$P_B = 3.8075 + 2.0901\ P_F$$

Zero-profit Line Intersections

Setting the P_B's for adjacent processes equal to each other, we can readily solve for the feed price at which their zero-profit lines intersect. This feed price is then substituted back into one zero-profit line equation to get the broiler price at which the intersection occurs, then into the other as a check. For example, with 3.50- and 3.25-pound birds:

$$3.5416 + 2.1259\ P_F = 3.8075 + 2.0901\ P_F$$

Solving, the horizontal coordinate (feed price) of the intersection point is:

$$P_F = 7.4274$$

Substituting this feed price back into the 3.50-pound zero-profit equation:

$$P_B = 3.5416 + (2.1259)\ (7.4274)$$
$$P_B = 19.33$$

Table 2.--Annual broiler production, feed consumed, and chicks started per 1,000 square feet of floor space, by weight of broilers when marketed, Card-Scott, 1952 1/

Live weight (in pounds)	Lots per year	Production		Feed consumed			Chicks started		
		Total per 1,000 square feet	Additional per 1,000 square feet	Total per 1,000 square feet	Additional		Total per 1,000 square feet	Additional	
					Per 1,000 square feet	Per pound of added product 2/		Per 1,000 square feet	Per pound of added product 2/
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Number	100 pounds	100 pounds	100 pounds	100 pounds	Pounds	100 chicks	100 chicks	Chicks
4.50	3.2	126.40	---	444.93	---	---	30.27	---	---
4.25	3.3	133.02	6.62	441.02	-3.91	-0.59	33.61	3.34	0.50
4.00	3.5	141.82	8.80	447.81	6.79	0.77	37.89	4.28	0.49
3.75	3.7	150.29	8.47	452.47	4.66	0.55	42.67	4.78	0.56
3.50	3.9	159.89	9.60	463.67	11.20	1.17	48.45	5.78	0.60
3.25	4.1	170.87	10.98	478.96	15.29	1.39	55.55	7.10	0.65
3.00	4.3	183.58	12.71	500.59	21.63	1.70	64.41	8.86	0.70
2.75	4.6	196.02	12.44	516.78	16.19	1.30	74.81	10.40	0.84
2.50	4.8	210.66	14.64	533.37	16.59	1.13	88.17	13.36	0.91
2.25	5.1	228.10	17.44	558.60	25.23	1.45	105.76	17.59	1.01

1/ These 1952 Card-Scott results were adjusted for an estimated death loss of 1/2 percent per week.

2/ The marginal feed input rises so steeply between 4.25 and 4.50 pounds with this function that it takes more feed to produce less product at heavier weight. Stated the other way around, more product can be produced with less feed by shifting from 4.50- to 4.25-pound broilers. In this instance, the calculation of "additional feed consumed per pound of added product" is: $\frac{441.02 - 444.93}{133.02 - 126.40} = \frac{-3.91}{6.62} = -0.59$. Calculation of "additional chicks started per pound of added product" is made in a similar manner.

Source: Hansen and Mighell (7).

Table 3.--Annual broiler production, feed consumed, and chicks started per 1,000 square feet, by weight of broilers when marketed, Wabeck-Skoglund, 1963 1/

Live weight (in pounds)	Lots per year	Production		Feed consumed			Chicks started		
		Total per 1,000 square feet	Additional per 1,000 square feet	Total per 1,000 square feet	Additional		Total per 1,000 square feet	Additional	
					Per 1,000 square feet	Per pound of added product 2/		Per 1,000 square feet	Per pound of added product 2/
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Number	100 pounds	100 pounds	100 pounds	100 pounds	Pounds	100 chicks	100 chicks	Chicks
4.50	4.5	179.19	---	401.54	---	---	41.41	---	---
4.25	4.7	186.83	7.64	413.93	12.39	1.62	45.64	4.23	0.55
4.00	4.8	195.56	8.73	427.89	13.96	1.60	50.67	5.03	0.58
3.75	5.0	204.64	9.08	441.69	13.80	1.52	56.46	5.79	0.64
3.50	5.2	215.36	10.72	457.84	16.15	1.51	63.56	7.10	0.66
3.25	5.4	227.08	11.72	474.63	16.79	1.43	62.05	8.49	0.72
3.00	5.7	240.84	13.76	493.96	19.33	1.40	82.64	10.59	0.77
2.75	6.0	256.52	15.68	514.91	20.95	1.34	95.87	13.23	0.84
2.50	6.3	275.00	18.48	538.56	23.65	1.28	112.85	16.98	0.92
2.25	6.6	297.00	22.00	565.09	26.53	1.21	135.19	22.34	1.02

1/ These Wabeck-Skoglund results were based on the 1963 broiler feeding trials, and were adjusted for an estimated 0.4 percent mortality per week.

2/ The "additional feed consumed per pound of added product" is calculated as follows:

$\frac{413.93 - 401.54}{186.83 - 179.19} = \frac{12.39}{7.64} = 1.62$. Calculation of "additional chicks started per pound of added product" is made in the same manner: $\frac{45.64 - 41.41}{186.83 - 179.19} = \frac{4.23}{7.64} = 0.55$.

Source: Wabeck and Skoglund (21).

Checking, with the 3.25-pound zero-profit equation:

$$P_B = 3.8075 + (2.091)\ (7.4274)$$
$$P_B = 19.33$$

The right-hand boundary of the optimum weight zones, which separates them from the "loss" area, is made up of a series of segments of zero-profit lines. These are drawn from one intersection point to the next; for that particular range of broiler prices, they represent the process (broiler weight) that can cover its costs at the highest feed price.

Equal-net-return Lines

Every point on each boundary between optimum-weight zones represents a pair of broiler and feed prices at which the two adjacent processes yield equal net returns. The right-hand end of each of these boundaries is the intersection point of two zero-profit lines, where the net returns are zero for both adjacent processes. Our remaining problem is to determine what combinations of broiler and feed prices will maintain the equality of net returns as we move to the left from the zero-profit intersection point. Moving to the left means lowering the price of feed. Since the two processes do not use the same amount of feed, reducing the feed price will add more to the net returns of one process than to the other. Hence, the broiler price must be changed to offset this advantage if equality of net returns is to be maintained, but by how much?

Coming back to the net-returns equations for the two adjacent processes:

$$N_{3.25} = 227.08\ P_B - 474.63\ P_F - 72.05\ P_C$$

and

$$N_{3.50} = 215.36\ P_B - 457.84\ P_F - 63.56\ P_C$$

The equality to be maintained is $N_{3.25} = N_{3.50}$, and, therefore,

$$227.08\ P_B - 474.63\ P_F - 72.05\ P_C = 215.36\ P_B - 457.84\ P_F - 63.56\ P_C.$$

We wish to keep the net returns from the two processes equal while the prices of both broilers and feed vary. The price of chicks, P_C, remains unchanged; therefore, $\Delta\ P_C = 0$, and the third term on each side of the equation drops out. We have left:

$$227.08\ \Delta\ P_B - 474.63\ \Delta\ P_F = 215.36\ \Delta\ P_B - 457.84\ \Delta\ P_F$$

Solving, we get:

$$\Delta\ P_F = 0.6980\ \Delta\ P_B$$

Therefore, for each $1 reduction in the price of feed, the broiler price must be reduced by 70 cents in order to maintain the equality of net returns from the two processes.

By the same procedure, the equal-net-returns boundaries separating the other adjacent pairs of processes are located, and the price map is complete.

Three points stand out in the price maps of figure 3. First, the entire cost structure of broiler production has been lowered. The zero-profit lines are lower and further to the right; this means that out-of-pocket costs can be covered at lower broiler prices with any given price of feed. The equal-net-returns line between 2.25- and 2.50-pound broilers has shifted sharply downward, with a more gradual slope. Therefore, the lower cost structure has made it profitable for broiler firms to maximize output at lower prices than formerly. Note that broiler output continued to expand in the early 1960's, despite the lowest broiler-feed price ratios on record. Ten years earlier such prices surely would have brought widespread and disastrous losses.

Second, an increase in the broiler-feed price ratio makes it profitable for commercial broiler firms to market their birds at lighter weights, since this is the only way they can expand output from a given floor space. On the other hand, when the objective is to maximize net returns per broiler, the appropriate response to higher price ratios is the exact opposite--to increase marketing weights.

Third, the optimum-weight zones of the right-hand map of figure 3 are much narrower than those of the one on the left. This suggests that the penalty for producing a moderately heavier- or lighter-than-optimum broiler is substantially less than formerly, unless the market pays a premium for the nonoptimum weight. This hypothesis can be tested by applying some recent broiler and feed prices to the Wabeck-Skoglund model and comparing the indicated optimum with the average weight of broilers marketed in that year. The widest discrepancy occurred in 1960, when the model showed an optimum weight of 2.75 pounds, but the actual average was 3.4 pounds (table 4). This is a substantial weight difference, but the penalty is surprisingly small. The annual loss was $44 per 1,000 square feet of floor space, or 1/5 cent a pound. The second largest deviation was in 1961, when the loss was 1/10 cent a pound. These penalties can be more than offset by market price differentials of only a fraction of a cent. They are much smaller than those indicated by Hansen and Mighell (7, p. 16).

What light does this throw on the gradual increase in the average marketing weight of broilers? The U. S. average rose from 3.1 pounds live weight in 1955 to 3.5 pounds in 1964. Similar increases took place in most of the major producing States (table 5).5/

Several factors have combined to strengthen the competitive position of heavier broilers. One effect of the shift in the broiler production function is that feed conversion rates are now better maintained into the heavier weights. This has materially lessened the cost disadvantage of larger broilers. In addition, figure 3 shows how lower broiler-feed price ratios have helped tip the balance of advantage toward bigger birds.

5/ The average for Maine broilers was pushed up by the increasing production of heavier birds variously called "roasters" or "fryers," and that for Virginia held down by the trend toward the "squab" broiler, a relatively light bird. While both these specialty items command a premium in the market, the demand for them is limited.

Table 4.--Prices of broilers and feed, and optimum and actual marketing weight of broilers, 1960-64

Year	Average broiler prices per pound	Average feed price per hundredweight	Broiler-feed price ratio 1/	Optimum weight 2/	Average actual weight
	Cents	Dollars		Pounds	Pounds
1960	16.9	4.62	3.7	2.75	3.4
1961	13.9	4.64	3.0	4.50	3.4
1962	15.2	4.67	3.3	3.50	3.4
1963	14.5	4.80	3.0	4.25	3.5
1964	14.2	4.81	3.0	4.50	3.5

1/ The number of pounds of feed 1 pound of broiler will buy.
2/ Wabeck-Skoglund model, 1963.

Market preferences may have shifted toward larger broilers, too. The trend toward merchandising cut-up poultry may have improved the acceptability of heavier broilers among many consumers. Actually, consumers may have favored the heavier weights all along, but paid too small a premium to overcome the former cost barrier. Broiler price data are not available by weight classes, and it is not possible to establish the importance of this factor.

Finally, narrowing profit margins and rising wage rates have made processing costs a factor of increasing importance. It costs about the same to process a heavy broiler as a light one, but significantly less per pound. This suggests that the pressure to reduce processing costs has further contributed to the shift toward heavier broilers.

Seasonal Changes

The workings of the model presented in figure 3 can be further illustrated by the seasonal swings of price and production in several of the major broiler-producing States. Although one marketing weight appears to have very little cost advantage over another, broiler firms do vary the weight at which their birds are marketed as one means of adjusting output to seasonal changes in demand.

Demand for chicken meat is high in the summer months, and prices normally hold up well under the seasonally heavy marketings (fig. 4). In the late fall, however, many consumers turn to more traditional items and broiler prices weaken, even with lighter marketings. Prices tend to reach their seasonal high in the first 3 months of the year because winter broilers are somewhat more costly to produce and marketings tend to be low during this period. There is some indication that the increasing prevalence of improved broiler house insulation and ventilation is enabling more growers to take advantage of these favorable prices. If this trend continues, these early-year swings in prices and output may become somewhat reduced.

Table 5.--Broilers: Average live weight per bird marketed, United States and specified States, 1935-64

Year	U. S.	Ala.	Ark.	Calif.	Del.	Ga.	Md.	Maine	Miss.	N. C.	Pa.	Tex.	Va.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1935	2.8	---	2.9	3.0	3.0	2.5	3.0	3.2	2.4	2.3	2.7	2.0	3.2
1940	2.9	2.4	3.2	3.0	3.0	2.4	3.0	3.2	2.5	2.6	3.0	2.0	3.2
1945	3.0	2.4	2.8	3.1	3.1	2.8	3.2	3.9	2.7	2.9	3.5	2.3	3.1
1950	3.1	2.7	2.8	3.4	3.0	2.8	3.0	4.4	2.8	2.8	3.5	2.7	3.1
1951	3.1	2.7	2.8	3.3	3.0	2.8	3.0	4.1	2.8	2.8	3.5	2.8	3.1
1952	3.0	2.7	2.8	3.3	3.1	2.8	3.1	3.8	2.8	2.8	3.4	2.8	3.1
1953	3.1	2.6	2.8	3.3	3.1	2.9	3.1	3.8	2.7	2.9	3.2	2.9	3.1
1954	3.1	3.0	2.8	3.2	3.1	2.8	3.1	3.6	2.8	2.9	3.4	2.9	3.1
1955	3.1	3.1	2.8	3.1	3.1	2.9	3.1	3.6	2.8	3.0	3.3	2.9	3.1
1956	3.2	3.1	2.8	3.3	3.3	3.1	3.3	3.6	2.9	3.1	3.4	3.0	3.2
1957	3.2	3.2	2.9	3.2	3.4	3.2	3.4	3.8	3.1	3.1	3.5	3.0	3.1
1958	3.3	3.2	3.0	3.3	3.5	3.2	3.4	3.8	3.1	3.3	3.5	3.0	3.1
1959	3.3	3.3	3.1	3.4	3.5	3.3	3.5	3.8	3.1	3.3	3.6	3.1	3.1
1960	3.4	3.2	3.1	3.5	3.7	3.3	3.7	3.9	3.2	3.3	3.7	3.2	3.1
1961	3.4	3.4	3.2	3.6	3.7	3.4	3.7	4.2	3.3	3.4	3.8	3.3	3.1
1962	3.4	3.3	3.2	3.6	3.8	3.3	3.8	3.9	3.3	3.4	3.9	3.3	3.0
1963	3.5	3.4	3.3	3.7	3.8	3.4	3.8	4.0	3.3	3.4	3.9	3.3	3.0
1964	3.5	3.4	3.3	3.7	3.8	3.4	3.8	4.0	3.3	3.5	3.9	3.4	3.1

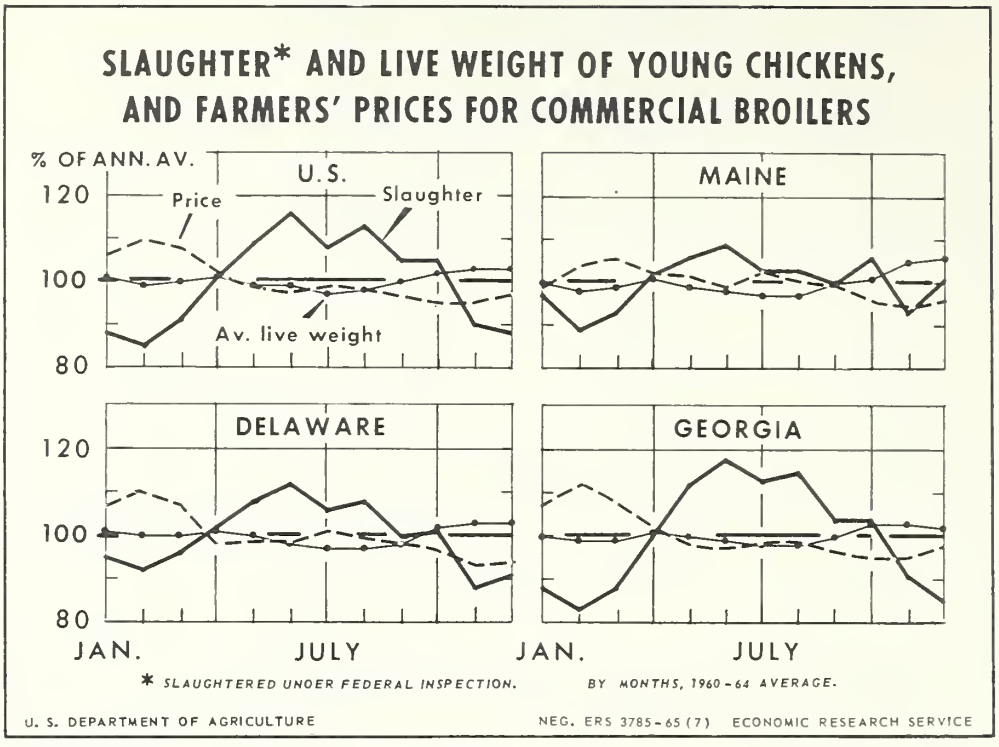

Figure 4

Managers of broiler firms have good reason to feel like "a man on a tightrope." If they market more broilers than their regular outlets can handle, they have to find other buyers. In a slow market, this means they can move their surplus birds only at a sharp discount. On the other hand, high-volume operations are vital to the profitability of their feed mills, hatcheries, and broiler-processing plants. Hence, one of the major problems facing these firms is to keep their plants operating as near capacity as possible without depressing broiler prices excessively.

In the summer months, when demand is generally brisk, broiler firms tend to rush their birds to market sooner and at lighter weights than at other times of the year. They also try to shorten the cleanout time in order to start new lots as quickly as possible. They may even grow two or more successive lots on the same litter if the grower has had no particular disease problem with his birds.

Conversely, when demand slackens and broiler prices decline in the late fall months, broiler firms lengthen the production period and market their broilers at heavier weights. They often extend the period between cleanout and placement of new lots of chicks. They may also drop some of their marginal producers, and even pay some of their more efficient ones on a standby basis to keep from losing them to a competing firm. Thus, changing the weight at which broilers are marketed is one of several means employed to adjust output to seasonal fluctuations in demand. But the central point here is that the seasonal adjustments of broiler firms are consistent with those they have made over a period of several years. When prices are favorable, one way they expand production is to market lighter broilers; when prices are less favorable, one means of reducing output is to market lighter broilers.

LITERATURE CITED

(1) Baum, E. L., and Fletcher, H. B.
1953. Application of Profit Maximizing Techniques to Commercial Fryer Enterprises. Poultry Sci. 32:415-423.

(2) Bluestone, Herman
1963. The Cycles in Broilers. U. S. Dept. Agr., Econ. Res. Serv., Poultry and Egg Situation, PES-226:13-18, July.

(3) Boone, M. A.
1955. Extra Floor Space Means More Profit From Broilers. S. C. Agr. Expt. Sta., Agricultural Research, July.

(4) Card, L. E., and Scott, H. M.
1953. Yardstick for Maximizing Returns From Broiler Growing. Southeastern Poultryman, p. 54, Jan.

(5) Clark, T. B.
1953. How Much Floor Space? W. Va. Agr. Expt. Sta. Bul. 357.

(6) Economic Research Service
1964. The Poultry and Egg Situation. U. S. Dept. Agr., PES-234, 54 pp., Nov.

(7) Hansen, Peter L., and Mighell, Ronald L.
1956. Economic Choices in Broiler Production. U. S. Dept. Agr. Tech. Bul. 1154, 27 pp., Dec.

(8) Hartung, T. E.
1955. Floor Space for Broilers. Poultry Sci. 34:1200.

(9) Heady, Earl O., Balloun, Stanley, and McAlexander, Robert
1956. Least-Cost Rations and Optimum Weights for Broilers. Iowa Agr. Expt. Sta. Res. Bul. 442:835-864, Oct.

(10) Hodges, Earl F.
1964. Consumption of Feed by Livestock. U. S. Dept. Agr., Econ. Res. Serv., Prod. Res. Rpt. 79, 94 pp., Mar.

(11) Judge, George G., and Fellows, Irving F.
1953. Economic Interpretations of Broiler Production Problems. Conn. Agr. Expt. Sta. Bul. 302, 35 pp., July.

(12) Judge, George G., Plaxico, James S., Brooks, Don L., and others
1959. The Economics and Technical Impact of Floor Space Per Bird and Temperature in Broiler Production. Okla. Agr. Expt. Sta., Processed Ser. P-318, 26 pp., Apr.

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1928. Growth of Chickens in Relation to Feed Consumption. Jour. Agr. Res. 36 (6):541-550, Mar. 15.

(14) Nurse, J., Trant, G., and Walker, J.
1960. Broiler Weights and Profits. Ontario Agr. Col., Guelph, Ontario, Canada, 51 pp.

(15) Smith, R. C.
1955. What Age and Weight to Market Broilers? Del. Agr. Ext. Serv., 6 pp., Apr.

(16) Smith, R. C., and McDaniel, W. E.
1952. Floor Space Affects Broiler Profits. Del. Agr. Expt. Sta. Cir. 25, Sept.

(17) SPICE Subcommittee on Production and Business Management
1962. New Standards Set for N. Y. Broiler Growers. Everybody's Poultry Mag. 67 (9):16-17, Sept.

(18) Stoddard, Everett O.
1963. Efficiency Gains in Broiler Production. U. S. Dept. Agr., Econ. Res. Serv., Farm Cost Situation, FCS-34:37-43, May.

(19) Thayer, R. H., Godfrey, G. F., and Thompson, R. B.
1953. Floor Space for Broilers. Okla. Agr. Expt. Sta. Bul. B-402, June.

(20) Tobin, Bernard F., and Arthur, Henry B.
1964. Dynamics of Adjustment in the Broiler Industry. Harvard Univ. Press, 164 pp.

(21) Wabeck, C. J., and Skoglund, W. C.
1963. Growth and Feed Standards for Broilers—1963. N. H. Agr. Expt. Sta., Sta. Bul. 478, 3 pp., Oct.